

REMARKS

At the time of the Office Action dated December 16, 2005, claims 1-26 were pending in this application. Of those claims, claims 16-26 have been withdrawn from consideration pursuant to the provisions of 37 C.F.R. §1.142(b).

In this Amendment, claims 5, 6, 11-13 and 15 have been amended, claims 1-4 and 7-10 canceled, and new claims 27 and 28 added. Care has been exercised to avoid the introduction of new matter. Specifically, claims 5, 6, 11 and 12 have been amended to be in independent form. Claims 5, 11 and 13 have also been amended to recite a new limitation, adequate descriptive support of which can be found on, for example, page 17, lines 13-16 of the specification. In addition, adequate descriptive support for new claims 27 and 28 can be found on, for example, page 30, lines 15-17 of the specification.

It is noted that the rejection of claims 1-4 and 7-10 has been rendered moot by cancellation of those claims. Claims 5, 6, 11-15, 27 and 28 are now active in this application.

The Rejection of Claims 6, 12 and 15 under 35 U.S.C. §112, second paragraph

The Examiner pointed out that the word “plain” recited in claims 6, 12 and 15 makes these claims indefinite. In response, Applicant has amended claims 6, 12 and 15 to replace the word “plain” with --plane--. Withdrawal of the rejection of claims 6, 12 and 15 under 35 U.S.C. §112, second paragraph is respectfully solicited.

The Rejection of Claim 12 under 35 U.S.C. §102(e)

Claim 12 has been rejected under 35 U.S.C. §102(e) as being anticipated by Xia et al. In the statement of the rejection, the Examiner asserted that “Xia et al. discloses in Fig. 1E that a

metal interconnect 106 is provided in the dielectric film, such that an upper surface of the metal interconnect 106 and that of the dielectric film are aligned in the same plane” (lines 12-14 in paragraph 7 of the Office Action). This rejection is respectfully traversed.

In response, Applicant submits that the Examiner’s assertion that Xia et al. teach the limitation of claim 12 is unreasonable. Applicant specifically stresses that the Examiner did not identify what in Xia et al. corresponds to the dielectric film of the claimed invention. According to Xia et al., reference 102 of Fig. 1E indicates a low k dielectric layer, reference 104 indicates a silicon oxycarbide hardmask, reference 106 indicates a horizontal interconnect, and reference 110 indicates a planar surface. Fig. 1E of Xia et al. shows that an upper surface of interconnect 106 and that of hardmask 104 formed on dielectric layer 102 are aligned in the same plane. It is therefore apparent from Fig. 1E that an upper surface of interconnect 106 and that of dielectric layer 102 are not aligned in the same plane in Xia et al.

Accordingly, Applicant submits that Xia et al. do not disclose a semiconductor device including all the limitations recited in claim 12 within the meaning of 35 U.S.C. §102. Applicant, therefore, respectfully solicits withdrawal of the rejection of claim 12 under 35 U.S.C. §103 as evidenced by Xia et al., and favorable consideration thereof.

The Rejection of Claims 13 and 14 under 35 U.S.C. §102(b)

Claims 13 and 14 have been rejected under 35 U.S.C. §102(b) as being anticipated by Wallace et al. In the statement of the rejection, the Examiner asserted that Wallace et al. disclose a nanoporous dielectric films with graded density identically corresponding to what is claimed.

In response, independent claim 13 has been amended to recite that “the dielectric film includes an area where density of said pores varies gradually toward the upper surface or the

lower surface of said dielectric film.” Based on Applicant’s study of Wallace et al., the reference does not disclose that density of the pores varies gradually toward the upper surface or the lower surface of the dielectric film, as claimed.

Accordingly, Wallace et al. do not disclose a semiconductor device including all the limitations recited in independent claim 13, as amended, within the meaning of 35 U.S.C. §102. Dependent claim 14 is also patentably distinguishable over Wallace et al. at least because it includes all the limitations recited in independent claim 13. Applicant, therefore, respectfully solicits withdrawal of the rejection of claims 13 and 14 under 35 U.S.C. §102, and favorable consideration thereof.

The Rejection of Claim 5 under 35 U.S.C. §103(a)

Claim 5 has been amended under 35 U.S.C. §103(a) as being unpatentable over Forbes et al. in view of Wallace et al. In the statement of the rejection, the Examiner admitted that Forbes et al. do not disclose pores being distributed in a relative lower density in the proximity of an upper surface of the dielectric film. The Examiner, then, applied Wallace et al., and asserted that the reference teaches the missing feature of Forbes et al. The Examiner concluded that it would have been obvious to modify Forbes et al. based on the teachings of Wallace et al. to arrive at the claimed invention.

In response, Applicant submits that the applied combination of Forbes et al. and Wallace et al. does not teach a semiconductor device including all the limitations recited in claim 5, as amended. Specifically, the applied combination does not teach, among other things, that “the dielectric film includes an area where the density of said pores varies gradually toward the upper surface of said dielectric film,” recited in claim 5. Introduction of porous dielectric film reduces

interconnect capacitance, and mitigates insufficient adhesion and degradation of mechanical characteristics of the dielectric film.

Wallace et al. relate to nanoporous dielectric films with graded density. Wallace et al. can provide a dielectric film with a greater mechanical strength and a lower dielectric constant in other areas. Forbes et al. pertains to a method of forming an insulating material. Forbes et al. provide alternative methods for insulating conductive elements from one another with low-dielectric-constant materials, the purpose of which is different from that of Wallace et al. Based on Applicant's review of those references, the applied combination of Forbes et al. and Wallace et al. does not teach that "the dielectric film includes an area where the density of said pores varies gradually toward the upper surface of said dielectric film," recited in claim 5.

Accordingly, Applicant submits that the applied combination of Forbes et al. and Wallace et al. does not teach a semiconductor device including all the limitations recited in claim 5, as amended, within the meaning of 35 U.S.C. §103. Applicant, therefore, respectfully solicits withdrawal of the rejection of claim 5 under 35 U.S.C. §103, and favorable consideration thereof.

The Rejection of Claim 6 under 35 U.S.C. §103(a)

Claim 6 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Forbes et al. in view of Xia et al. In the statement of the rejection, the Examiner admitted that Forbes et al. do not teach that the metal interconnect provided in the dielectric film has an upper surface that does not lie in the same plane as the upper surface of the dielectric film. The Examiner, however, applied Xia et al., and asserted that the reference teaches the missing feature of Forbes et al. The Examiner concluded that it would have been obvious to modify Forbes et al. based on

the teachings of Xia et al. to arrive at the claimed invention. This rejection is respectfully traversed.

In response, Applicant submits that the Examiner's assertion that Xia et al. teach the limitation of claim 6 is unreasonable. The Examiner asserted as follows:

Xia et al. discloses in Fig. 1E that a metal interconnect 106 is provided in the dielectric film, such that an upper surface of the metal interconnect 106 and that of the dielectric film are aligned in the same plane, wherein the upper surface of the metal interconnect and the upper surface of the dielectric film lie on the same plane for the disclosed intended purpose of forming a local interconnect that needs an exposed surface to connect to other areas of the device. See lines 6-11 in paragraph 11 of the Office Action (emphasis added).

In the above portion, the Examiner did not identify what in Xia et al. corresponds to the dielectric film of the claimed invention. Reference 102 of Fig. 1E indicates a low k dielectric layer, reference 104 indicates a silicon oxycarbide hardmask, reference 106 indicates a horizontal interconnect, and reference 110 indicates a planar surface. Fig. 1E of Xia et al. shows that an upper surface of interconnect 106 and that of hardmask 104 formed on dielectric layer 102 are aligned in the same plane. It is therefore apparent that an upper surface of interconnect 106 and that of dielectric layer 102 are not aligned in the same plane in Xia et al.

Accordingly, Applicant submits that the applied combination of Forbes et al. and Xia et al. does not teach a semiconductor device including all the limitations recited in claim 6 within the meaning of 35 U.S.C. §103. Applicant, therefore, respectfully solicits withdrawal of the rejection of claim 6 under 35 U.S.C. §103 as predicted upon Forbes et al. in view of Xia et al. and favorable consideration thereof.

The Rejection of Claim 11 under 35 U.S.C. §103(a)

Claim 11 has been rejected under 35 U.S.C. §103 as being unpatentable over Xia et al. in view of Wallace et al. In the statement of the rejection, the Examiner admitted that Xia et al. does not teach the pores being distributed in a relatively lower density in the proximity of an upper surface of the dielectric film. The Examiner, then, applied Wallace et al. and asserted that the reference teaches the missing feature of Xia et al. The Examiner concluded that it would have been obvious to modify Xia et al. based on the teachings of Wallace et al. to arrive at the claimed invention.

In response, Applicant submits that the applied combination of Xia et al. and Wallace et al. do not teach a semiconductor device including all the limitations recited in claim 11, as amended. Specifically, the applied combination does not teach, among other things, that “the dielectric film includes an area where the density of said pores varies gradually toward the upper surface of said dielectric film,” recited in claim 5. Introduction of porous dielectric film reduces interconnect capacitance, and mitigates insufficient adhesion and degradation of mechanical characteristics of the dielectric film.

Wallace et al. relate to nanoporous dielectric films with graded density. Wallace et al. can provide a dielectric film with a greater mechanical strength and a lower dielectric constant in other areas. Xia et al. pertains to a method for depositing a silicon oxycarbide hardmask over a low k dielectric film, the purpose of which is different from that of Wallace et al. Based on Applicant’s review of those references, the applied combination of Xia et al. and Wallace et al. does not teach that “the dielectric film includes an area where the density of said pores varies gradually toward the upper surface of said dielectric film,” recited in claim 11, as amended.

Accordingly, Applicant submits that the applied combination of Xia et al. and Wallace et al. does not teach a semiconductor device including all the limitations recited in claim 11, as

amended, within the meaning of 35 U.S.C. §103. Applicant, therefore, respectfully solicits withdrawal of the rejection of claim 11 under 35 U.S.C. §103, and favorable consideration thereof.

The Rejection of Claim 15 under 35 U.S.C. §103(a)

Claim 15 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Wallace et al. in view of Xia et al.

In response, claim 15 is patentably distinguishable over Wallace et al. and Xia et al. at least because the claim includes all the limitations recited in independent claim 13. As discussed above, a semiconductor device recited in claim 13 is not disclosed by Wallace et al. It is also apparent that Xia et al. do not teach that density of the pores varies gradually toward the upper surface or the lower surface of the dielectric film.

Accordingly, the applied combination of Wallace et al. and Xia et al. does not teach a semiconductor device including all the limitations recited in claim 15 within the meaning of 35 U.S.C. §103. Applicant, therefore, respectfully solicits withdrawal of the rejection of claim 15 under 35 U.S.C. §103, and favorable consideration thereof.

New Claims 27 and 28

New claims 27 and 28 are patentably distinguishable over the cited references at least because the claims respectively include all the limitations recited in independent claims 6 and 12. Applicant respectfully solicits favorable consideration of claims 27 and 28.

Conclusion

It should, therefore, be apparent that the imposed rejections have been overcome and that all pending claims are in condition for immediate allowance. Favorable consideration is, therefore, respectfully solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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